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# **Minerals in the East Mojave National Scenic Area, California: An Economic Analysis Volume II**



**U.S. Department  
of the Interior  
Bureau of Mines**

MINERALS IN THE EAST MOJAVE  
NATIONAL SCENIC AREA, CALIFORNIA:  
AN ECONOMIC ANALYSIS  
VOLUME II

By

Radford Schantz  
Robert Adams

Nicholas Wetzel  
Russell G. Raney

Division of Policy Analysis      Western Field Operations Center

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<b>16. Abstract (Limit: 200 words)</b> In 1990, the Bureau of Mines (BOM) conducted a mineral investigation of the mines and prospects in the East Mojave National Scenic Area (EMNSA), San Bernardino County, California. During field work, BOM identified 701 mines and prospects in EMNSA for which the geology, mineral resources, and mining history were compiled and summarized. Analytical results for 1,188 rock samples collected are tabulated. Total value of identified resources in EMNSA is \$7.7 billion.  Twenty-four mines and prospects were deemed profitable under current economic conditions. Development could generate considerable economic benefits to San Bernardino County. Potential economic benefits from mining the deposits were evaluated under the following access restrictions for EMNSA: 1) full access, 2) HR 3460, and 3) S 11/HR 780.  Under the full access scenario, cumulative mine revenues are \$3.0 billion, cumulative personal earnings at mines and supporting industries are \$0.94 billion, and annual jobs at mines and supporting industries are 2,379. Under HR 3460, mine revenues, personal earnings, and annual jobs are \$2.9 billion, \$0.88 billion, and 2,165, respectively. Under S 11/HR 780, mine revenues, personal earnings, and annual jobs are \$1.0 billion, \$0.32 billion, and 936, respectively.				
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## FOREWORD

The Bureau of Mines is publishing studies of minerals in the East Mojave National Scenic Area in two volumes. This volume provides estimates of the potential economic impacts of mineral withdrawals proposed in several bills before Congress. The companion volume is Minerals In the East Mojave National Scenic Area: A Minerals Investigation. That volume discusses the geology and mining history of the study area and gives the results of field investigations of minerals locations.

## CONTENTS

	<u>Page</u>
<b>Foreword.....</b>	3
<b>Executive summary.....</b>	7
<b><u>Chapter 1: Economic Analysis of Minerals Deposits</u></b>	
Introduction.....	9
Acknowledgments.....	9
Background.....	11
General .....	11
Economically important mineral commodities in the East Mojave National Scenic Area.....	19
Gold.....	19
Limestone.....	21
Sand and gravel.....	22
Wollastonite.....	22
Cinder and scoria.....	23
"Black sand".....	24
Clay.....	25
Pyrophyllite.....	25
Mine-mill cost estimates.....	26
Deposits included in estimates.....	26
Mine-mill cost models.....	26
References.....	32
<b><u>Chapter 2: Regional Economic Impacts of Proposed Restraints on Access to Minerals</u></b>	
Introduction.....	34
Proposed minerals access withdrawals.....	34
Need for this study.....	36
Acknowledgments.....	36
Methodology.....	36
Deposits included in estimates.....	36
Regional economic benefits estimated.....	37
San Bernardino County and EMNSA minerals.....	38
Mining and the regional economy.....	38
Estimates of potential economic impacts of S 11/HR 780 and HR 3460..	41
Summary of impacts of minerals access alternatives.....	41
Tables of estimated impacts.....	43
References.....	51

## ILLUSTRATIONS

<b>Plate 1. Current land status.....</b>	53
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### **Chapter 1**

1. Location map.....	10
2. Colosseum gold mine.....	16
3. Morning Star gold mine.....	16
4. Castle Mountains gold project.....	17
5. Aiken Mine and Cima Mine.....	17
6. Kelso Dunes ("Black Sand" operation.....	18
7. Mines and prospects in the East Mojave National Scenic Area....	20

## ILLUSTRATIONS (Cont.)

	<u>Page</u>
<b><u>Chapter 2</u></b>	
8. Legislation proposed for California Desert.....	35
9. Deposits included in estimates.....	37
10. Elements of regional impact analysis.....	38
11. San Bernardino County population distribution.....	40
12. Value of EMNSA minerals by commodity group.....	42

## TABLES

### **Chapter 1**

1. Recorded mineral production by commodity.....	13
2A. Identified metallic resources by commodity.....	14
2B. Identified nonmetallic resources by commodity.....	15
3. Mine-mill models, mineral resource summary.....	27
4. Mine-mill models, capital and operating costs.....	30

### **Chapter 2**

5. Employment in San Bernardino County.....	39
6. Potential impacts of East Mojave National Scenic Area mine construction.....	44
7. Potential impacts of East Mojave National Scenic Area mine production.....	45
8. Potential impacts of East Mojave National Scenic Area mine employees' expenses.....	46
9. Total potential impacts of mine construction and production....	48
10. Potential impacts of limestone product transport from East Mojave National Scenic Area.....	49
11. Potential taxes paid by mines.....	50

## LIST OF UNIT OF MEASURE ABBREVIATIONS

d/yr	day per year	st/yr	short ton per year
° F	degree Fahrenheit	stu	short ton unit
ft	feet	tr oz	troy ounce
h	hour	tr oz/st	troy ounce per short ton
in	inch	yd <sup>3</sup> /d	cubic yard per day
lb	pound	yr	year
pct	percent	10 <sup>6</sup> st	million short ton
st	short ton	10 <sup>3</sup> st	thousand short ton
st/d	short ton per day		

## EXECUTIVE SUMMARY

Recent bills in Congress would exclude mining from large areas of the California Desert. Despite the fact that the areas are highly mineralized, no estimates have been made available of the value and regional significance of mining currently profitable deposits, nor has the future potential of the total resource area been evaluated.

This study by the Bureau of Mines covers a part of the area considered for minerals access withdrawal, namely the East Mojave National Scenic Area (EMNSA). The study is limited to operating mines and known deposits that would apparently be profitable to develop under current economic conditions. There are judged to be 24 such mines and deposits (including gold, limestone, clays, and other minerals) among over 700 mines, prospects, and mineral occurrences in the area. These deposits could generate large production revenues resulting in considerable economic benefits to the San Bernardino County region. The table below summarizes estimates made of potential economic benefits from mining under different access restrictions for the EMNSA: (1) full access, (2) HR 3460, and (3) S 11/HR 780. The results indicate the need for additional evaluation of the economic impact of this legislation.

### Summary of economic benefits by minerals access alternatives

<u>Economic benefits to San Bernardino County</u>			
Cumulative mine revenues	Cumulative personal earnings at mines and supporting industries	Annual jobs at mines and supporting industries	
Full access...	\$3.0 billion	\$0.94 billion	2,379
HR 3460.....	2.9 billion	0.88 billion	2,165
S 11/HR 780...	1.0 billion	0.32 billion	936

NOTE.--Cumulative revenues are the sum over all deposits of production over the life of the mine (up to 20 yr), where production is valued by the price generating a 15 pct return. Cumulative personal earnings sum over all years of construction and production (up to 20 yr) for all deposits. Annual jobs are the sum over all deposits of average annual employment. None of the alternatives takes into account any administrative restrictions on access additional to legislative withdrawals. Totals do not include additional economic benefits from limestone product transport that have been estimated, including 840 jobs with \$29 million annual personal earnings, available under full access and HR 3460. Taxes paid by mines have also been estimated, including income, property, sales taxes, and permit fees.

Evidence suggests that presently unprofitable deposits, as well as resources not yet discovered in the EMNSA area, are extensive. The implication is that the proposals altogether would withdraw billions of dollars of minerals, depriving the regional economy of commensurately large economic benefits. Clearly, an assessment of these resources is needed. Additionally, much of the EMNSA at present is not fully open to mineral exploration and mining, due to land management policies and regulations. Such de facto withdrawals would compound the effects of legislative withdrawals. These constraints should also be considered.

# CHAPTER 1

## ECONOMIC ANALYSIS OF MINERAL DEPOSITS

by Nicholas Wetzel and Russell G. Raney

### INTRODUCTION

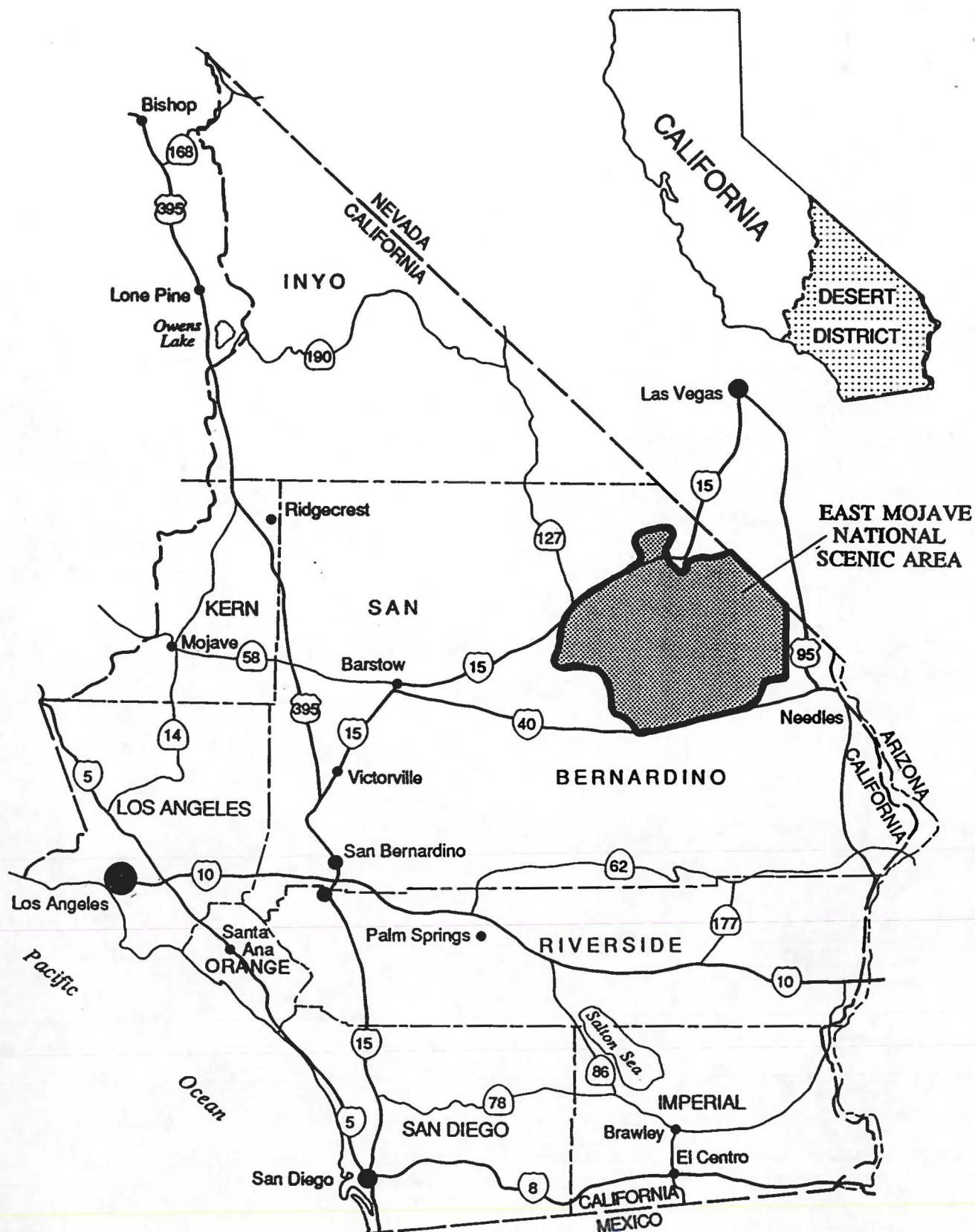
The Bureau of Mines is concerned that decisions affecting access to and use of Federal lands, which often contain extensive mineral resources, be made on the basis of adequate minerals information. Concerns about the adequacy of minerals information available for land-use decisions have been heightened in recent years by several bills before Congress that would designate large areas of the California Desert as parks or wilderness and prohibit mining (except at certain existing mines). Accordingly, the Bureau studied mineral deposits and the economic benefits of mining in a representative portion of the Desert, the East Mojave National Scenic Area (EMNSA) (fig. 1).

The "California Desert Protection Act" (CDP Act) was first introduced by Senator Alan Cranston in 1986 and has been reintroduced with modifications several times, currently under the titles S 11 and HR 780. These bills would transfer management of 6 million acres of Federal land from the Bureau of Land Management (BLM) to the National Park Service (NPS), creating three national parks (including the 1.5 million acre EMNSA), and mandate over 4 million acres of BLM managed wilderness. Late in 1989, another bill, HR 3460, was proposed regarding the CDCA. Less restrictive than the CDP Act, this bill would designate about 2 million acres wilderness to be administered by BLM. These bills are driven by concerns for scenic and environmental values. However, the current BLM management philosophy of multiple use generally takes into account aesthetic values as well as other productive uses of the land.

Multiple use management calls for information about significant resource values including economic analysis when appropriate. The objective of the Bureau is to present information that may assist administrators, legislators, and the concerned public to understand the economic importance of mineral resources in the California Desert, especially that portion designated as the EMNSA.

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The authors wish to thank Bureau colleagues Ronald T. Mayerle and Nicholas T. Zilka for data collection and critical reviews; Thomas W. Camm, David S. Lindsey, and James M. Spear for mine-mill modeling and costing; James Ridenour and Larry C. Reigel for the computer graphics; and William N. Hale and his section for production and resource data.



Redrawn from BLM (1)

FIGURE 1.— Location map--East Mojave National Scenic Area, San Bernardino County, CA

## BACKGROUND

### General

In late 1980, the Secretary of the Interior designated the East Mojave region of the California Desert as a National Scenic Area (fig. 1). Known by its acronym, EMNSA, the area includes approximately 1.5 million acres of Federal, State, and private lands in the northeastern portion of San Bernardino County adjacent to the California-Nevada border (1)<sup>1</sup>. The center of the Scenic Area is 70 miles southwest of Las Vegas, NV, 60 miles northwest of Needles, CA, and 90 miles east of Barstow, CA. The East Mojave has seen significant human use over the past 100 yr, first for its grazing resources, then for its mineral wealth, and since the 1960s for recreation. The area also provides corridors for transportation and utilities between the Greater Los Angeles Area and resource and population centers in Nevada and Utah (1, p. 6).

This long history of varied land-use priorities in the California Desert has produced established patterns of ownership, and land management policies and regulations enforced by those owners. While the intent of certain regulations and policies may not be to restrict mineral activities, the restrictions imposed may in a practical sense preclude those activities and represent a de facto mineral withdrawal. Recognizing this to be the case, the Bureau has been documenting the availability of Federal lands for mineral entry through its Inventory of Land-Use Restraints Program, using the following categories:

*Available:* Lands where mineral resource development is routinely initiated by private industry. The managing agencies' practices do not discourage or preclude mineral exploration and/or development.

*Slightly to moderately restricted:* Lands where the practical effects of legal constraints or agency management practices may discourage private industry from initiating mineral exploration and/or development.

*Unavailable or severely restricted:* Lands that are closed to operation of some or all of the mineral laws, or areas, where the practical effects of legal constraints or management practices greatly discourage private industry from initiating exploration and/or development.

Using this classification, at the present time, 4 pct of the Federal lands in the EMNSA are available, 1 pct are slightly to moderately restricted, and 95 pct are unavailable or severely restricted. Distribution of these various lands is shown on plate 1. Any newly proposed mineral withdrawals should be considered in this context.

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<sup>1</sup>Underlined numbers in parentheses refer to items in the list of references at the end of each chapter.

The scenic appeal of the EMNSA is, in most part, a function of the area's geology and climate. It hosts an extraordinary range of rock types from Precambrian marine sediments (some moderately to intensely metamorphosed) to Quaternary volcanics and alluvial deposits. Folding, faulting, uplift, and other tectonic events have produced striking landforms. The landscape has been further modified by geomorphic processes such as weathering and stream and wind action. During the Pleistocene, large lakes formed in intramontane valleys. Upon drying, the lakebeds became the flat playas so prevalent in the area.

The unique and complex geology of the EMNSA has also endowed it with a great mineral wealth. Mining of this wealth has been, and will continue to be (barring proposed land withdrawals from mineral entry), important in the economies of the EMNSA and San Bernardino County. Over 700 mines, prospects, and mineral locations are indicated to be in the area by the Bureau's Mineral Industry Location System (MILS).

A summary of EMNSA mine production, likely representing incomplete data, is presented on a commodity basis in table 1. Identified EMNSA metallic resources and nonmetallic resources, based on readily-available data, are summarized in tables 2A and 2B, respectively.

Several operating and developing mines are now producing, or can produce on demand, important mineral commodities such as gold (figs. 2, 3, 4), silver, wollastonite, limestone, clay (fig. 4), volcanic cinder (fig. 5), heavy mineral concentrates ("black sand") (fig. 6), pyrophyllite, and sand and gravel.

A brief description of each commodity and an identification of those properties in the EMNSA associated with the particular commodity(ies), is presented in the following section. Mine and mill cost models, developed as part of the economic study, are based on these commodities.

TABLE 1. - Recorded mineral production by commodity,  
East Mojave National Scenic Area

Commodity	Quantity	Largest producing mines in order of descending output	Years of production
METALS			
Gold, tr oz.....	539,5651	Colosseum.....	1929-1939, 1987-1990
		Morning Star.....	1907-1943, 1986-1990
		New Trail.....	1916-1919, 1929-1950
Silver, tr oz...	602,0142	Beatrice.....	1870-1880
		Copper World.....	1906-1940
		Death Valley.....	1907-1920
		Mohawk.....	1918-1952
		Bonanza King.....	1883-1887, 1901-1960
		Monitor.....	1889-1942
		Standard No. 1...	1902-1908
		Boomerang.....	1897-1925
Copper, 1b.....	8,037,910	Copper World.....	1906-1940
		Standard No. 1...	1902-1908
		Mohawk.....	1918-1952
		New Trail.....	1916-1919, 1929-1950
		Sagamore.....	1901-1951
Lead, 1b.....	8,966,153	Copper World.....	1906-1940
		Mohawk.....	1918-1952
		Sagamore.....	1901-1951
Zinc. 1b.....	1,793,422	Mohawk.....	1918-1952
Iron, st.....	1,501,000	Vulcan.....	1942-1947
Tin, 1b.....	3,200	Evening Star.....	1941
Tungsten, stu..	3,630	Mojave Tungsten..	1915, 1916
		Standard No. 2...	1934
		Evening Star.....	1941
		Hartmann.....	1941
NONMETALS			
Bentonite, st..	500	Getchell.....	?
Cinders, st....	1,560,000	Aiken.....	1954-1990
Fluorite, st...	4,538	Cima.....	1948-1960
		Pacific.....	1955-1961
		Juniper.....	1955
Gemstone, 1b...	100,000 <sup>e</sup>	Copper World.....	1977-1978
Kaolin, st....	552,837	C-1 Clay.....	1937-1986
		P. S. Hart.....	1933-1986
Magnesite, st..	125	New Trail.....	1918, 1930
Marble, st.....	100	Geer Dolomite....	?
Perlite, st....	6,217	Erin/More-Lite...	1945-1952
Talc, st.....	25,000 <sup>e</sup>	Rose.....	Current

<sup>e</sup> estimate.

<sup>1</sup>324,700 tr oz of gold production from 1986-90.

<sup>2</sup>Does not include an estimate for Beatrice Mine of \$3.5 million bullion product (Hewett, 1956) from 1870-80 (estimated 3.5 million tr oz of silver).

TABLE 2A. - Identified metallic resources by commodity, East Mojave National Scenic Area

Commodity	Mine-property	Area	Quantity, thousands	Value, \$ millions
Gold.....	Big Horn.....	Providence Mountains.....	50 tr oz	19
	Castle Mountain.....	Castle Mountains.....	2,000 tr oz	780
	Colosseum.....	Clark Mountains.....	290 tr oz	110
	Globe (includes silver).....	Providence Mountains.....	5 tr oz	3
	Getchell.....	Hackberry Mountains.....	W	W
	Golden Quail.....	New York Mountains.....	90 tr oz	35
	Ivan Group.....	Ivanpah Mountains.....	W	W
	Lucky Mine.....	Old Dad Mountain.....	W	W
	Morning Star.....	Ivanpah Mountains.....	180 tr oz	69
	Rattlesnake.....	Vontrigger Hills.....	W	W
	Telegraph.....	Cinder area.....	37 tr oz	15
	Vanderbilt.....	New York Mountains.....	W	W
	Undistributed.....	.....	426 tr oz	164
Total.....			3,075 tr oz	1,185
Iron.....	Black Jack.....	Providence Mountains.....	93 st	5
	Cornfield Springs.....	..do.....	66 st	3
	Iron Victory.....	Granite Mountains.....	52 st	3
	Old Dad.....	Old Dad Mountain.....	320 st	17
	Vulcan.....	Providence Mountains.....	1,500 st	78
	Total.....	.....	2,031 st	106
Molybdenum.....	Big Hunch.....	New York Mountains.....	47,000 lb	210 <sup>1</sup>
Silver.....	Castor Pollux (including gold)	Providence Mountains.....	215 tr oz	2
	Death Valley.....	New York Mountains.....	236 tr oz	2
	Juniper.....	Clark Mountains.....	3,000 tr oz	17
	Teutonia.....	Teutonia Peak (Cima Dome)...	W	W
	Total.....	.....	W	W
Tungsten.....	Tungsten King.....	New York Mountains.....	W	W
Other undistributed	.....	.....	.....	394
Total.....			1,930	

W Withheld.

<sup>1</sup>The BLM in its final EIS (V. G., revised January 1982) on the California Desert Conservation Area infer a resource of 800 million lb of molybdenum (p. 103). This BLM data was preliminary and subject to revision. Subsequent work by the Bureau of Mines was unable to substantiate this larger estimate.

TABLE 2B. - Identified nonmetallic resources by commodity, East Mojave National Scenic Area

Commodity	Mine-property	Area	Quantity, 10 <sup>6</sup> st	Value, \$ M
Cinders.....	Aiken.....	Cinder cones.....	8	32
Cima.....	Cima.....	..do.....	12	48
	Cinder.....	..do.....	30	120
Clay:				
Bentonite.....	Getchell.....	Hackberry Mountains...	W	W
Kaolin.....	Castle Mountains.....	Castle Mountains.....	7	568
Do.....	C-1 Open Pit.....	..do.....	W	W
Do.....	White Hart No. 1.....	..do.....	W	W
Dolomite-Limestone.	Dolomite (Goodsprings Fm.).	Providence Mountains..	12	48
	Georgia Marble (dolomite)..	Striped Mountains.....	50	200
	Ivanpah Limestone (Meevint Claims).	New York Mountains....	W	W
	Pleuss-Staufer Limestone...	..do.....	W	W
Wollastonite.....	Ivanpah Wollastonite.....	..do.....	W	W
Fluorite.....	Copper Queen.....	..do.....	W	W
	Juniper.....	Clark Mountains.....	0.075	121
Perlite.....	Erin-Moreelite.....	Castle Mountains.....	2	66
Stone:				
Decorative.....	Rainbow Group.....	Cowhole Mountains.....	W	W
Sand:				
Industrial.....	Kelso Dunes.....	Kelso Dunes.....	16,000 (main dune field)	no est.
Talc.....	Rose.....	New York Mountains....	1	112
Other undistributed	.....	.....	254	1,914
Total.....				3,110

<sup>15</sup>  
Total included with metal value.



FIGURE 2. - Colosseum gold mine--East Mojave National Scenic Area, San Bernardino County, CA.



FIGURE 3. - Morning Star gold mine--East Mojave National Scenic Area, San Bernardino County, CA.



FIGURE 4. - Castle Mountains gold project--East Mojave National Scenic Area, San Bernardino County, CA, showing P. S. Hart clay pits.

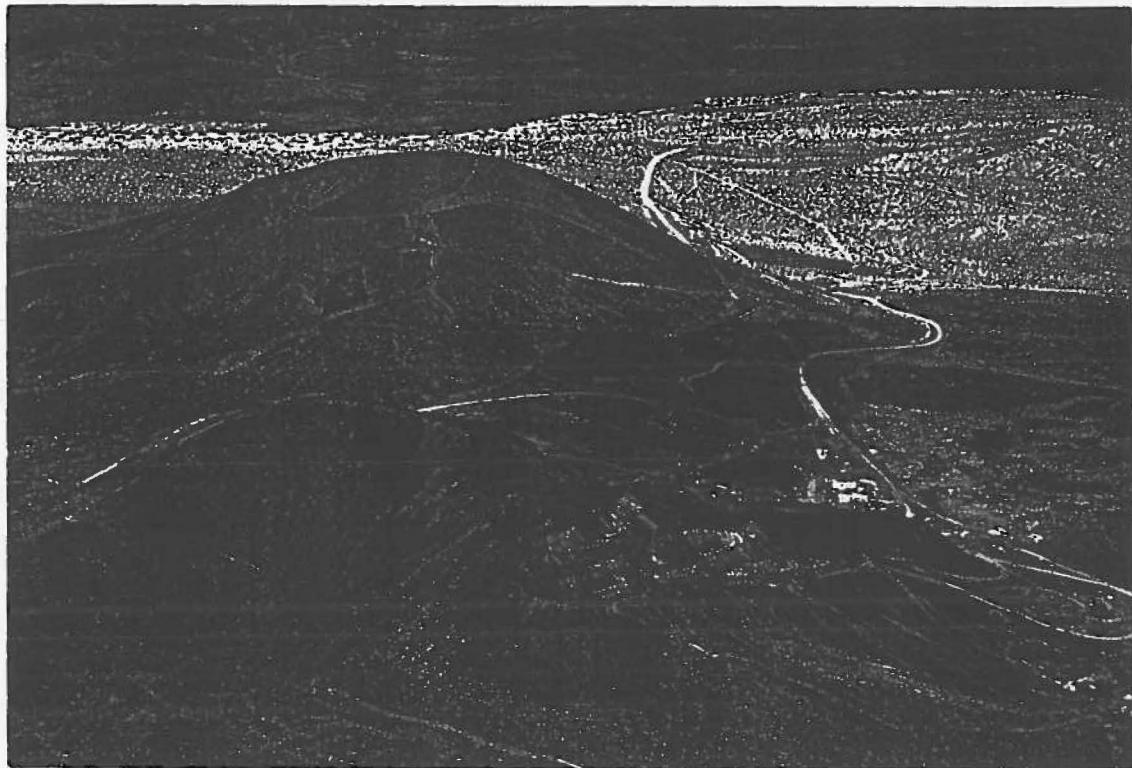


FIGURE 5. - Aiken Mine (foreground) and Cima Mine (background)--East Mojave National Scenic Area, San Bernardino County, CA.



FIGURE 6. - Kelso Dunes "Black Sand" operation--East Mojave National Scenic Area, San Bernardino County, CA.

## Economically Important Mineral Commodities in the East Mojave National Scenic Area

### Gold

The United States, since 1986, has had the distinction of being the third largest gold producer behind the Republic of South Africa and the Soviet Union. In 1989, U.S. mines contributed 7.7 million tr oz of gold to World supplies, a nearly 20 pct increase over 1988 production (2, p. 70). Strong exploration programs, mineral processing advancements, and more streamlined development methods have made gold one of very few mineral commodities for which the United States is independent. This is demonstrated by a net gold export of over 2.2 million tr oz in 1989 (2, p. 70).

In recent years, exploration for gold worldwide has far exceeded that for other mineral commodities. In the United States, exploration (along with the majority of the producing mines) was concentrated primarily in the Western States. Nevada and California were first and second in 1989 gold output, producing an estimated 5.0 million (3, p. 26) and 891,000 tr oz (4, pp. 13, 83-85), respectively (3). The industry is rapidly expanding and gold is being discovered in areas previously thought to have had little or no mineral potential. New exploration technologies, and a new and substantially better understanding of the geology of gold deposits, have contributed greatly to the further development of past producing areas and to the discovery of obscure new deposits. Advanced extraction and processing technologies allow the economic recovery of gold from ore as low as 0.01 tr oz/st of gold.

Gold is the most sought after commodity in the EMNSA. Lode and placer claims are located in nearly every local terrain and rock type (5). Hot-spring deposits, high-grade limestone replacement bodies near granitic contacts, silicified Jurassic-Triassic meta-volcanics, placers, and low-grade disseminated ore deposits are either present or possible.

Two producing mines, the Colosseum (fig. 2) and the Morning Star (fig. 3), and two developing mines, the Ivanpah, and the Castle Mountains (fig. 4), are within the EMNSA. Potential future mines include the ODM and Reveille, Ruby Group, Golden Quail, Rattlesnake-Rat Group, Cat Group, Hack and Back, and the Getchell (fig. 7). The ultimate indicator of areal potential in the EMNSA is the frequency and distribution of the gold deposits and substantiated gold occurrences, which are both numerous and widespread.

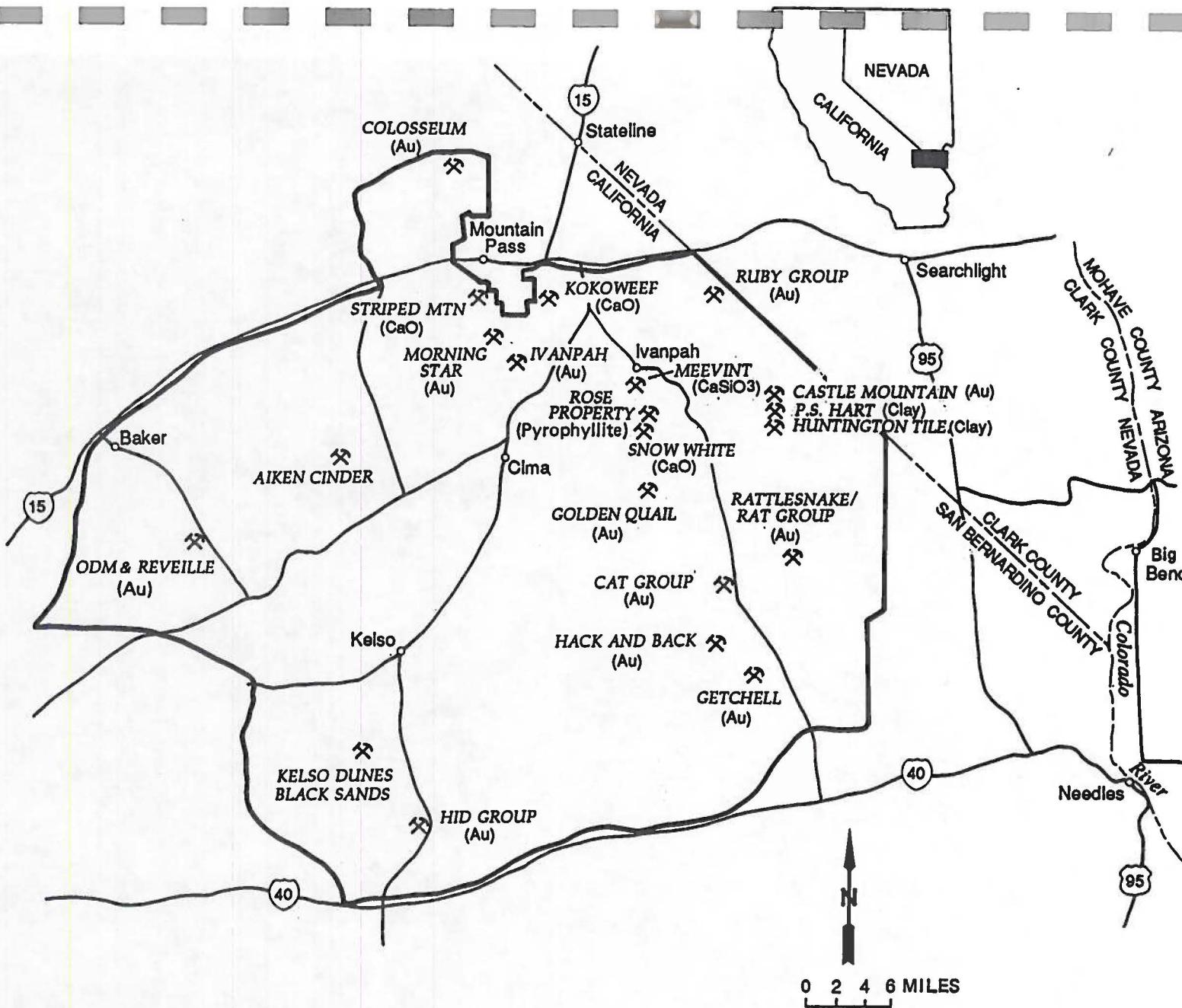


FIGURE 7.— Mines and prospects in the East Mojave National Scenic Area, San Bernardino County, CA

## Limestone

Limestone is a sedimentary rock composed chiefly of the mineral calcite ( $\text{CaCO}_3$ ) the uses of which largely depend on its physical and/or chemical properties. Major limestone end products, both in the United States and abroad, include cement, lime, road aggregate, dimension stone, agricultural products (soil conditioners, poultry grit, and mineral food), flux, and mineral filler, extender, and whiting. The paper industry is converting from an acid sizing process to an alkaline process; this has created an increasing demand for high-grade limestone.

In California, limestone production of all types and grades tripled in the last 10 yr as new uses and markets were developed. Although limestone occurrences are common throughout the Mojave Desert, current southern California limestone production and processing are generally centered on three areas: the Victorville area, San Bernardino County; the Mojave area, Kern County; and the Gorman area, Los Angeles County. In the Victorville area, the limestone and cement industry is concentrated along a short belt extending from Victorville on the north to Lucerne Valley on the south. Practically no limestone is mined in southern California for use as aggregate as abundant sand and gravel resources are available.

Most limestone mined in the southern California market area is used in cement production; however, the most noteworthy products are the high-grade whiting products produced by Pfizer Inc. and Pluess-Staufer (California) Inc. from high-calcium and high-white-color deposits at Lucerne Valley. The two companies have an estimated combined annual production of  $1,350,000$  st of high-grade limestone, considerably less than the  $9.5 \cdot 10^6$  st of cement produced in California in 1986 (6). Southern California chemical and filler-grade limestone markets presently consume an estimated  $1.2 \cdot 10^6$  st annually.

Although limestone occurs at several locations in the EMNSA, the most important deposits are in the New York Mountains southeast of Ivanpah (fig. 7). There, very large reserves of limestone are contained in Paleozoic carbonate rocks overlain by Mesozoic sedimentary and volcanic rocks. Of primary importance are the limestone resources in the Devonian Sultan Limestone, the Mississippian Monte Cristo Limestone, and the Pennsylvanian Bird Spring Formation. Numerous samples collected from these units within the New York Mountains are reportedly of high purity containing more than 98 pct  $\text{CaCO}_3$ , less than 1 pct magnesium carbonate and less than 1 pct silicon dioxide (7, pp. 263-272). Further, chemical and brightness tests suggest the limestone is suitable for all low- and medium-grade products and, through selective mining, could produce rock suitable for all high quality products (7).

Pleuss-Staufer (California) Inc. and Pfizer Inc. have extensive holdings in the New York Mountains that have been moderately to extensively explored but have yet to be developed. Other major deposits of high purity limestone in the EMNSA include the Kokoweeef and Striped Mountain northwest of Ivanpah (fig. 7).

## Sand and Gravel

Sand and gravel deposits are found over much of the East Mojave National Scenic Area. The material is primarily Quaternary alluvium and is found to depths often exceeding 300 ft overlying Paleozoic through Tertiary rocks. Surprisingly, only a small fraction of the aggregate in the Quaternary alluvium is compositionally useful (8). Suitable deposits are found primarily in braided stream channels where sub- to well-rounded material may be useful as concrete aggregate, and in alluvial fans and desert washes, where angular material may be suitable for asphalt aggregate and other road work applications (9, 10).

Three reasons why much of the alluvium is not compositionally usable include (11):

(1) Ill-suited size fractions and reactivity, and lack of sufficient tonnage. In general, the closer to the source rock, the greater the chance of having usable aggregate (10).

(2) Inclusion of contaminants; caliche is a prime example. It requires the same amount of energy to crush caliche as rock. When wet, caliche acts like a lubricant and if included in road construction material, rapidly breaks down into a fine silt-like material. Road surfaces built with excessive amounts of caliche disintegrate more rapidly causing excessive and early replacement costs (8).

(3) Excessive moisture. Whether moisture is an integral part of the aggregate, or the aggregate absorbs moisture from underlying material, is not clearly understood. Its effects are well documented, however. In asphalt roads bearing heavy traffic, moisture drives the oil mixture from the aggregate, leading to premature road surface failure (8).

As aggregate deposits proximal to the Greater Los Angeles area and those adjacent to the Interstate highways currently being exploited are depleted, deposits within the EMNSA will be increasingly in demand.

## Wollastonite

Large deposits<sup>2</sup> of wollastonite are found in the United States (Arizona, California, Nevada, New Mexico, New York, and Utah), and in Mexico, U.S.S.R., Finland, Kenya, and Namibia (Southwest Africa).

<sup>2</sup>10 million or more short tons.

Wollastonite is a contact metamorphic mineral that occurs near the contacts of impure limestones and granitic or acidic intrusive rocks; it is also formed by the metasomatism of calcareous sediments and the recrystallization of certain magmas (12). The mineral, calcium metasilicate ( $\text{CaSiO}_3$ ), is extremely white when pure and breaks into acicular (needle-shaped) particles when crushed. These characteristics, combined with its high melting temperature ( $2800^\circ \text{ F}$ ), its inertness, and the high strength it imparts to finished products, contribute to wollastonite's versatility and diversified uses.

Wollastonite is used in the plastics industry for reinforcing thermoplastics and thermoset polymer compounds, and by the coatings industry as a pH stabilizer in interior and exterior PVA and acrylic latex systems. In ceramic floor and wall tile production, wollastonite can reduce firing time to less than 1 h, eliminate shrinkage defects, and save production time and fuel costs. When used in vinyl or asphalt floor tile, wollastonite imparts a brilliant whiteness, promotes low moisture absorption, provides resistance to wear, and increases strength. It also has been used as a substitute for asbestos in many applications.

California hosts a world-class wollastonite deposit in the Hunter Mountain (J.O.) Claims straddling the boundary of Death Valley National Monument in Inyo County. Hunter Mountain reportedly contains  $25 \text{ } 10^6 \text{ st}$  of proven and  $225 \text{ } 10^6 \text{ st}$  of probable resources. In recent years, efforts to develop the deposit have failed due to grade problems. However, the size of the deposit ensures that research to overcome this problem will continue. Other significant wollastonite deposits in California are in the Little and Big Maria Mountains, 20 miles southeast of Blythe, where the Minerals Division of Pfizer Inc., has mined small quantities, and at the Wolley Claims in the south-central portion of the Fort Irwin area west of the EMNSA.

Principal wollastonite operations in the EMNSA are located at the Meevint Mine south of Ivanpah (fig. 7).

#### Cinder and Scoria

Cinder and scoria have been in extensive use as lightweight building materials in Europe since the time of the Roman Empire. The materials' light weight, inertness, moisture-retention properties, and abrasiveness make cinder and scoria ideal for low-cost construction aggregates. The United States is the world's fourth leading producer and consumer of cinder and scoria behind Italy, Greece, and France.

Cinder and scoria are formed by the eruption of mafic lavas of sufficient viscosity and gas content to form rock fragments with abundant gas cavities (vesicles). The fragments commonly form cone-shaped hills that can reach hundreds of feet in height. By industry convention, "cinders" are those rock fragments less than 1 in. in largest dimension; "scoria" is 1 in. or greater.

Cinder, scoria, and related volcanic materials such as pumice and pumicite, are used both as mined (non-processed) ore and as carefully processed material. The principal end uses are abrasives for cleaning and scouring compounds, concrete aggregate and admixtures, railroad ballast, road construction, and landscaping. Miscellaneous uses include diluents; absorbents; carriers for insecticides, herbicides, and fungicides; soil conditioners; catalyst carriers; decolorizing and purifying agents; fillers and extenders for paints, enamels, varnishes, plastics, paper, and rubber goods; insulating medium; roofing granules; and lightweight refractory bricks (12).

Transportation costs are an important factor in the domestic cinder-scoria industry. Abrasive grades can be shipped even from foreign sources and be competitive. However, low-cost material, such as that used for construction aggregates, is usually limited to a few hundred miles by truck or rail from the mine.

The Aiken cinder mine, located in the Cima Volcanic Field about 20 miles east of Baker, CA (figs. 5, 7) is the major producer of cinder in the EMNSA. Mining of cinder and related volcanic materials has been ongoing in the Cima field since the early 1940s. The Aiken Mine has operated more or less continually since 1961 providing aggregate material primarily for the Las Vegas area.

#### "Black Sand"

Placer deposits of heavy minerals, sometimes referred to as "black sands," can form in any environment where such a mechanism is available to concentrate mineral grains of high specific gravity. Such mechanisms include winnowing by high velocity winds, fluvial transport, and wave action. Heavy minerals commonly associated with black sand deposits include, among others, gold, chromite, rutile, tin, magnetite, ilmenite, monazite, garnet, and zircon.

The Kelso Dunes, in the western part of the EMNSA near Devil's Playground (figs. 6, 7), embrace more than 52,000 acres of dune sands derived from a multitude of rock types, some of which hosted base-and precious-metals. Mineralized and barren rocks were decomposed through weathering processes to produce discrete mineral grains. Durable grains were further eroded and deposited by intermittent streams on alluvial fans or in stream channels that transect the dune fields. Some black sands were re-eroded by aeolian and/or alluvial processes and subsequently deposited in the dune field.

Kelso Dunes contain an estimated 80 billion st of sand (14). Of this, about 64 billion st is quartz sand and about 12 billion st is feldspar sand. Sample analyses indicate the dune sand contains 1 to 4 pct magnetite and averages 0.25 pct ilmenite and 0.0013 tr oz/st of gold<sup>3</sup> (locally as much as 0.5 tr oz/st of gold<sup>4</sup>).

<sup>3</sup>\$0.52 at \$400/tr oz gold price.

<sup>4</sup>\$200 at \$400/tr oz gold price.

Currently, dune sand is mined and processed by Mineral Extractors Inc. to recover magnetic minerals (as well as gold and platinum group metals) contained in the black sand fraction. The operation produces 15 st/d of magnetic concentrate that is trucked to processing facilities in Twentynine Palms, CA.

### Clay

In general, the term "clay" implies a natural, earthy, fine-grained material, derived largely from weathering and hydrothermal activity, which develops plasticity when mixed with a limited amount of water. "Plasticity" is the property of the moistened material to be deformed under the application of pressure, with the deformed shape being retained when the deforming pressure is removed. Clays are essentially composed of silica, alumina, and water, with appreciable amounts of iron, alkalies, and alkaline earths. (15). It is the unique combination of these physical and chemical properties that made clay a very important commodity in the ancient world, as well as in the world today.

In 1988, the United States produced an estimated  $48.5 \cdot 10^6$  st of clay materials (2, pp. 46-47). Major domestic uses for specific clays in 1988 were as follows: kaolin--paper, refractories, and rubber manufacture; ball clay--dinnerware and pottery, sanitary ware, floor and wall tile; fire clay--firebrick, foundry sands; bentonite--drilling mud, foundry sand bond, iron ore pelletizing; fuller's earth--adsorbent uses, insecticide dispersant; and common clay--construction materials (2, pp. 46-47).

California mines produced  $2.4 \cdot 10^6$  st of various clays in 1989.

Two clay mines are currently producing in the EMNSA, the P. S. Hart (figs. 4, 7) and the Huntington Tile (fig. 7). Operators at both deposits use dozers (with occasional blasting) to mine 7,500 st of material annually; mining and hauling is usually completed in less than 1 month. The clay ore is then transported to processing facilities in the Los Angeles area.

Proposed reclamation activities associated with the Castle Mountains gold project call for infilling of the P. S. Hart clay pits with mine waste material (16). Should this happen, it would effectively preclude future clay mining from this deposit.

### Pyrophyllite

Pyrophyllite is a hydrated aluminum silicate with physical properties almost identical to those of talc. The industrial uses of the mineral are similar to those of talc, and in mineral trade statistics, the two are seldom reported separately. Pyrophyllite, however, has the distinction of being the best material as a carrier of insecticides and insecticidal dusting powder (17).

Three firms in California and North Carolina accounted for 100 pct of domestic pyrophyllite production in 1989. Consumption was in ceramics, 55 pct; refractories, 14 pct, insecticides, 7 pct; and others, 24 pct.

The Rose Property (Sericite Mine) is an intermittently operating pyrophyllite mine in the EMNSA owned by The Conservation Fund (fig. 7). Pfizer Inc. operated the mine for about 20 yr during which time the deposit was known as the "Pyrophyllite Mine" (18).

Several thousand short tons of pyrophyllite have been produced annually for the last several years; mining takes place for 1 month during the summer. Actual total production and annual production rates are not known.

#### MINE-MILL COST ESTIMATES

##### Deposits Included in Estimates

Based upon the Bureau's Minerals Industry Location System, mining claim, company, published and Bureau file data, 24 (out of over 700 mineral occurrences) known, apparently profitable deposits in the EMNSA (fig. 7) were selected and analyzed. Known apparently profitable deposits include both existing mines and undeveloped deposits which give every indication that they would be profitable to mine under the economic conditions described in the previous section on commodities.

"Profitable" here means that a minimum 15 pct discounted cash flow rate of return (DCFROR) could be obtained. Current conditions within a 20-yr timeframe were assumed since market analysis and price forecasting were precluded by limited analytical resources. The included deposits can be thought of as reserves, ready to be developed on demand. If markets become more favorable in the future, additional deposits would become profitable, but these potential values are not considered in this analysis.

Assumptions employed in identifying undeveloped profitable deposits in the EMNSA included: (1) active claims held by major mining companies indicate deposits being seriously considered for development; and (2) field data collected by Bureau staff accurately verifies the existence and significance of deposits. Resource quantities and grades were estimated for identified deposits.

##### Mine-Mill Cost Models

This section contains brief mine and mill descriptions and associated capital and operating cost estimates used in the socioeconomic impact study. The cost estimates were derived from mine-mill cost models developed for the mineral deposits described in table 3. As some of the data used in the development of the cost models are proprietary, information on individual properties has been aggregated to avoid disclosure. Data presented in table 3 is keyed to the following categories:

<u>Category</u>	<u>Description</u>
1	Operating or developing gold deposits.
2	Operating or developing black sand, cinder, or pyrophyllite deposits.
3	Operating or developing clay deposits.
4	Limestone or wollastonite deposits that are profitable and can be developed on demand.
5	Sand and gravel deposits that are profitable and can be developed on demand.
6	Apparently profitable gold deposits.

TABLE 3. - Mine-mill models, mineral resource summary,  
East Mojave National Scenic Area

<u>Deposit category</u>	<u>No. of deposits</u>	<u>Commodities</u>	<u>Tonnage, st (total)</u>	<u>Grades</u>
1.....	4	Gold.....	30,000,000	0.055 to 0.07 tr oz/st gold.
2.....	1	Black sand..	50,000,000	1.26 pct magnetics.
	1	Cinders....	8,000,000	Shipping grade.
	1	Pyrophyllite	85,000	Do.
3.....	2	Clay.....	20,000,000	Do.
4.....	3	Limestone...	250,000,000	Includes both filler and cement grades.
	1	Wollastonite	200,000e	Shipping grade.
5.....	3	Sand-Gravel.	25,000,000 <sup>e</sup>	NAp.
6.....	8	Gold.....	30,000,000 <sup>e</sup>	0.058 to 0.074 tr oz/st gold.

e Estimated.

NAp Not applicable.

In developing each cost model, the mining and processing systems currently in use by the mine operator were incorporated. When such site-specific data were unavailable or proprietary, descriptions of mining-processing systems in use by operators of producing or developing mines of comparable commodity, size, and grade were employed. Other than proprietary and non-proprietary company data, all costs included in the models were calculated using the following sources of information:

- ° Mining Cost Service, published by Western Mine Engineering (19).
- ° Cost Reference Guide for Construction Equipment (20).
- ° Richardson Rapid System, Process Plant Construction Standards, Volume 4 (21).
- ° Richardson Rapid System, Process Plant Construction Standards, Volume 3 (22).
- ° Means Building Construction Cost Data (23).

All cost estimates were calculated in January 1990 dollars. The mining and processing systems in use or proposed for each deposit are summarized below.

Category 1 Deposits: Of the four gold deposits listed in category 1, two are operating and two are being developed. All deposits are or will be mined using open-pit methods. Stripping ratios range from as low as 2:1 up to 6:1.

Of the two operating properties, one uses a 3,400 st/d carbon-in-pulp (CIP) leach plant and the other uses a 8,000 st/d heap leach system. Both operations produce dore bullion.

For each of the two developing properties, 2,500 st/d heap leach systems are proposed to produce dore bullion.

All deposits operate 360 d/yr.

Category 2 Deposits: The three deposits listed in this category are producing mines.

The black sand operation uses front-loaders to mine 1,200 st/d of alluvial sand, 360 d/yr. The sand is treated in a magnetic separation plant to produce 15 st/d of 95 pct heavy mineral concentrate which is shipped a local facility for further processing. Processing includes the recovery of gold and platinum group metals.

The cinder operation employs dozers and rippers to mine 320 st/d. The ore is processed in a crushing and screening plant 312 d/yr. Screen plant products, which include material for cinder block and landscaping, are sold f.o.b. plant.

The Rose Mine (pyrophyllite) uses open-pit contract mining to produce 10,000 st/yr of ore per year (mined in less than 1 month). The ore is transported by truck to nearby secondary processing facilities.

Category 3 Deposits: Clay deposits in this category are currently producing. Both deposits are mined on a contract basis and employ dozers (with occasional blasting) to mine 7,500 st/yr. Mining and hauling is completed in less than 1 month during the summer. The ore is transported to processing facilities in the Los Angeles area.

Category 4 Deposits: Deposits in Category 4 include three undeveloped limestone and one undeveloped wollastonite properties that could be developed on demand.

Two of the limestone properties are classified as "filler grade" deposits (greater than 98 pct CaO) and could be quarried at a rate of 6,000 st/d, 260 d/yr. Broken ore would be crushed to minus 3/4 in, trucked to a rail siding, and hauled to processing facilities near Lucerne Valley, CA.

The third limestone deposit is classified as a "cement grade" deposit and could be mined by quarrying at a rate of 6,000 st/d, 260 d/yr. On-site processing would include crushing to minus 3/4 in, grinding to minus 200 mesh, and calcining to produce a limestone clinker. Grinding and calcining operations would occur 360 d/yr. The clinker product would be transported by rail to cement finish mills in Lucerne Valley, CA.

The wollastonite deposit could be open-pit mined on a contract basis at a rate of 10,000 st/yr; mining and hauling would generally be completed in less than 1 month. The ore would then be hauled to Victorville, CA for crushing and grinding.

Category 5 Deposits: The sand and gravel models summarized in Category 5 represent one operation for resurfacing county roads, one operation for resurfacing State and interstate highways, and one operation to supply various aggregates for local construction use.

The San Bernardino County road maintenance sand and gravel operation mines 210 yd<sup>3</sup>/d, 240 d/yr. The aggregate is screened at 1 in. and the undersize is mixed with 5 pct SC800 oil (cold mix) and hauled to the road construction site. A single operation resurfaces approximately 25 miles/yr. County roads within the EMNSA boundaries total 290 miles and will take 12 yr to resurface.

CALTRANS resurfacing of 110 miles of Interstate 15 and 140 miles of Interstate 40 requires 12 10<sup>6</sup> st of aggregate and will take 14 yr to complete. Aggregate is mined at a rate of 4,000 st/d, 208 d/yr, using dozers and rippers. The aggregate is crushed and screened to produce approximately 2,000 st of minus 3/4 in, plus 4 mesh material which is mixed with 4 pct AR8000 and AR4000 oil (approximately 1:1 ratio) in a plant to produce asphalt (hot mix). The asphalt is hauled to the road construction site. Cost estimates in the model include resurfacing.

The model developed for a private sand and gravel operation is based on a typical aggregate producer in San Bernardino County. Mining, using dozers and rippers, produces 2,400 st/d, 253 d/yr. A crushing and screening plant would produce various sizes of sand and gravel products. All products are sold f.o.b. plant site.

Category 6 Deposits: The eight gold deposits included in this category are identified exploration targets where medium-sized (1,000 to 5,000 st/d) deposits may be developed in the near future. Of the eight deposit models, seven incorporate open-pit mining at the rate of 1,000 st/d of ore and 2,000 st/d of waste, 360 d/yr. The eighth model calls for open-pit mining of 3,000 st/d of ore and 7,000 st/d of waste, 360 d/yr. All models use a drip heap leach system and produce dore bullion which is transported to the Handy and Harmon refinery in El Monte, CA.

Table 4 summarizes capital and annual operating costs for each aggregated category of deposits.

TABLE 4. - Mine-mill models, capital and operating costs  
East Mojave National Scenic Area

(U.S. dollars x 10<sup>6</sup>)

CAPITAL COSTS			
Item	Category 1	Category 2	Category 3
Construction labor...	\$11.774	\$1.111	\$0
Design fees.....	7.691	0.514	0
Permits.....	6.409	.428	0
Bonds.....	.521	.035	0
Working capital.....	11.060	.456	0.351
Sand and gravel.....	1.716	0	0
Fuel.....	1.385	.058	0
Repair parts.....	1.148	.039	0
Lubricants.....	.361	.015	0
Steel items.....	.417	.011	0
Tires.....	.136	0	0
Explosives.....	.353	0	0
Steel pipe.....	.311	0	0
Plastic pipe.....	.722	0	0
Plastic liners.....	2.809	0	0
Metal fences.....	.071	0	0
Structures.....	.291	.009	0
Lumber.....	.134	0	0
Electrical.....	.567	.299	0
Transmission line....	1.688	0	0
Concrete.....	1.481	.155	0
Structural steel.....	.864	.306	0
Insulation.....	.094	.005	0
Maintenance equipment	.183	.037	0
Furnishings.....	.281	.045	0
Instruments.....	.449	.094	0
Process equipment....	7.148	1.348	0
Mobile equipment.....	26.447	.580	0
Freight.....	2.440	.147	0
Sales tax.....	2.748	.129	0
Total.....	91.695	5.821	.351

OPERATING COSTS			
Item	Category 1	Category 2	Category 3
Labor.....	24.106	.761	.074
Electric power.....	1.661	0	0
Repair parts.....	8.467	.220	.027
Fuel.....	5.379	.304	.021
Propane.....	2.584	.247	0
Oil.....	0	0	0
Lubricants.....	2.266	.035	.007
Tires.....	2.623	.042	.016
Steel.....	1.928	.009	.002
Explosives.....	3.936	.001	.001
Reagents.....	9.190	0	0
Plastic liners.....	4.715	0	0
Plastic pipe.....	1.966	0	0
Contract costs.....	4.284	.079	.202
Rail transport.....	0	0	0
Sales tax.....	2.606	.022	.001
Total.....	75.710	1.719	.351

TABLE 4. - Mine-mill models, capital and operating costs--Continued

(U.S. dollars x 10<sup>6</sup>)

Item	CAPITAL COSTS		
	Category 4	Category 5	Category 6
Construction labor...	\$23.318	\$0.869	\$24.068
Design fees.....	13.585	.040	10.152
Permits.....	10.099	.140	7.678
Bonds.....	1.278	.100	.685
Working capital.....	17.548	1.079	14.054
Sand and gravel.....	3.239	.001	3.552
Fuel.....	2.643	.004	2.234
Repair parts.....	2.076	.003	1.790
Lubricants.....	.671	.001	.580
Steel items.....	4.363	0	.687
Tires.....	.155	0	.175
Explosives.....	.277	0	.455
Steel pipe.....	.769	.012	.846
Plastic pipe.....	0	.147	.687
Plastic liners.....	0	0	3.298
Metal fences.....	0	0	.113
Structures.....	1.018	0	.541
Lumber.....	1.415	.001	.158
Electrical.....	3.843	0	1.551
Transmission line....	1.266	0	1.583
Concrete.....	4.142	.023	2.617
Structural steel.....	2.989	.001	1.907
Insulation.....	.564	0	.230
Maintenance equipment	.508	.211	.609
Furnishings.....	.279	0	.589
Instruments.....	1.309	.059	.906
Process equipment....	20.406	3.334	15.031
Mobile equipment.....	30.045	9.313	15.443
Freight.....	3.710	1.001	2.074
Sales tax.....	1.201	.652	2.873
Total.....	155.716	16.990	117.166
OPERATING COSTS			
Item	Category 4	Category 5	Category 6
Labor.....	9.155	2.931	22.540
Electric power.....	3.275	0	.838
Repair parts.....	3.847	1.163	4.757
Fuel.....	1.680	.862	4.698
Propane.....	18.793	0	.788
Oil.....	0	.683	0
Lubricants.....	.488	.228	1.325
Tires.....	.585	.251	1.205
Steel.....	.220	.029	.805
Explosives.....	.680	0	2.017
Reagents.....	0	0	4.677
Plastic liners.....	0	0	1.661
Plastic pipe.....	0	0	1.512
Contract costs.....	.079	0	7.938
Rail transport.....	39.955	0	0
Sales tax.....	.373	.149	1.457
Total.....	79.131	6.295	56.218

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## CHAPTER 2

### REGIONAL ECONOMIC IMPACTS OF PROPOSED RESTRAINTS ON ACCESS TO MINERALS

by Radford Schantz and Robert Adams

#### INTRODUCTION

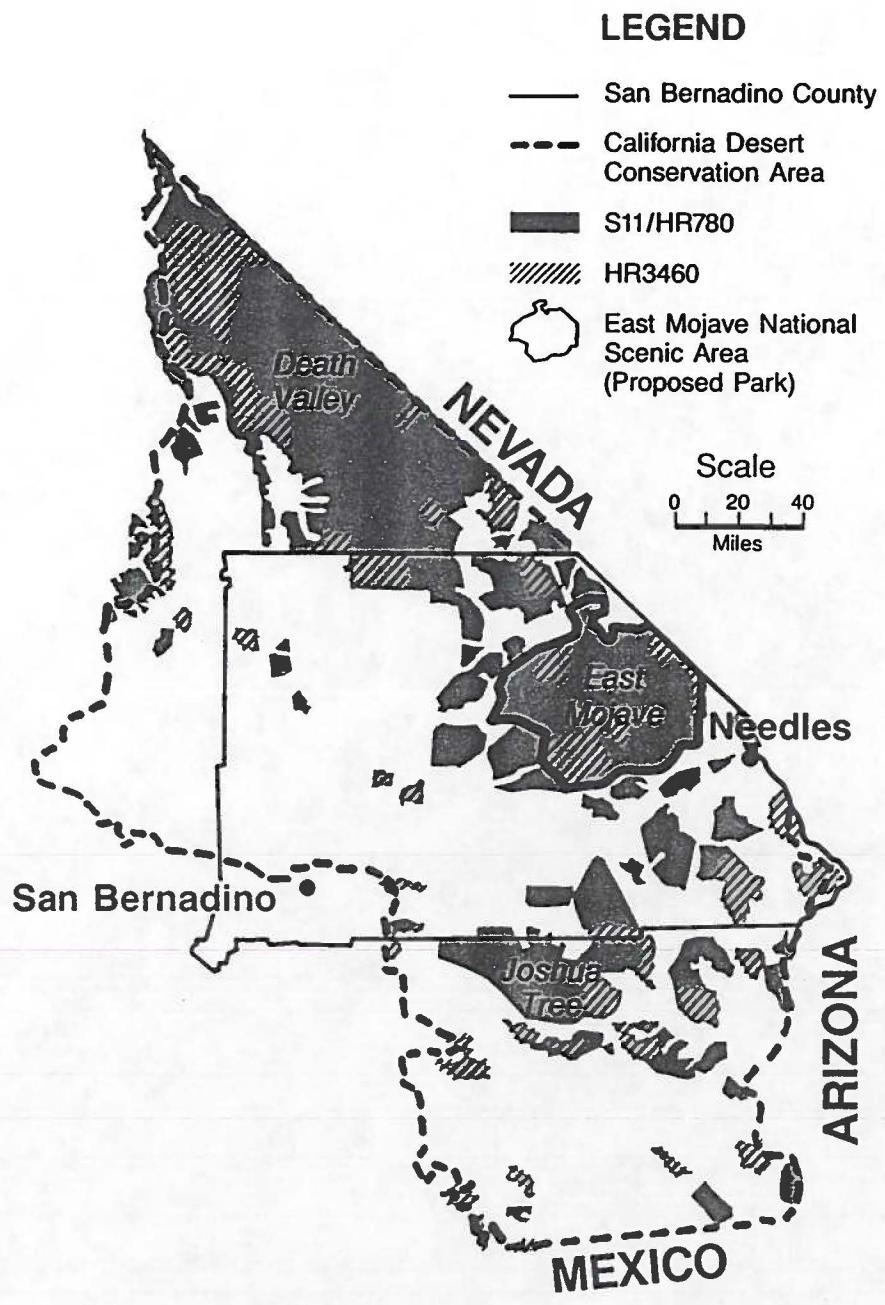
##### Proposed Minerals Access Withdrawals

Several bills are before Congress that would designate large areas of the California Desert as parks or wilderness and prohibit mining (except at certain existing mines). The Bureau of Mines is concerned that decisions affecting access to and use of Federal lands, which often contain extensive minerals, be made on the basis of adequate minerals information (24). However, regarding these bills, no estimates have been made available of the value and regional significance of mining currently profitable deposits, nor has the future potential of the total area resource been evaluated.

The "California Desert Protection Act" (CDP Act) was first introduced by Senator Cranston in 1986 and has been reintroduced with modifications several times, currently under the titles S 11 and HR 780 (25). These bills would transfer management of 6 million acres of Federal land from the Bureau of Land Management (BLM) to the National Park Service (NPS), creating three national parks (including a 1.5-million-acre East Mojave National Park) and mandate over 4 million acres of BLM-managed wilderness. The areas lie within the 25-million-acre California Desert Conservation Area (CDCA) established in 1976. The CDCA is illustrated in figure 8. As shown, the total area affected by the CDP Act amounts to 10 million acres (which is larger than the State of Maryland).

Late in 1989, another bill, HR 3460, was proposed regarding the CDCA. Less restrictive than the CDP Act, this bill would designate about 2 million acres wilderness, to be administered by BLM. Although not officially sponsored by the Administration, this bill resembles wilderness recommendations that BLM has prepared.

This study covers only the area that is proposed by S 11/HR 780 as the Mojave National Park. This is approximately the same area that is presently designated the East Mojave National Scenic Area (EMNSA). The study also covers the wilderness areas in the EMNSA that would be withdrawn under HR 3460. The findings for this limited area indicate that the entire withdrawal area needs economic minerals assessment.



U.S. Bureau of Mines

**FIGURE 8.** - Legislation proposed for California Desert.

### Need for This Study

The Bureau of Mines has been investigating the minerals potential of proposed wilderness areas in the California desert area since 1980. Some previously studied areas lie within the proposed Mojave National Park, but the full 1.5 million acres of the proposed park had not yet been studied. Park classification implies economic issues which until now had not been adequately addressed. One issue is the profitability of mining in the East Mojave, that is, how many mines are active, how many additional deposits currently being explored or held in reserve are economical, and what is the potential value of production. Another is the regional significance of mining in the East Mojave, that is, how withdrawals would affect the regional economy and reduce tax revenues. A further issue, not addressed in this study, is the economic potential of undiscovered resources.

Although there are a number of reports on minerals in the California desert (26, 27), none fully address the above issues. A vital information gap remains, and this study is a step towards filling it.

### ACKNOWLEDGEMENTS

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### METHODOLOGY

#### Deposits Included in Estimates

This study analyzes the potential impacts of withdrawals affecting mining only at existing mines and known, apparently profitable deposits in the EMNSA. Since this 1.5-million-acre park is only a part of the total acreage that would be withdrawn, the full impacts would be considerably greater than the estimates given here.

As explained in chapter 1, known apparently profitable deposits include both existing mines and undeveloped deposits which give every indication that they would be profitable to mine at or near current economic conditions.

Deposits are estimated to be "profitable" if the mine could generate a 15 pct discounted cash flow rate of return at a product price at, or near, current (1990) market price. The deposits included can be thought of as reserves, ready to be developed on demand. If markets become more favorable in the future, additional deposits would become profitable, but these potential values are not considered in this analysis (28).

The estimates do not include the additional potential value of undiscovered resources, yet evidence suggests that the potential values are considerable. Quantitative methods for estimating undiscovered resources are available, having been developed and applied by the Bureau and the U.S. Geological Survey (29).

To summarize, figure 9 indicates classes of deposits and places a box around that included in the estimates.

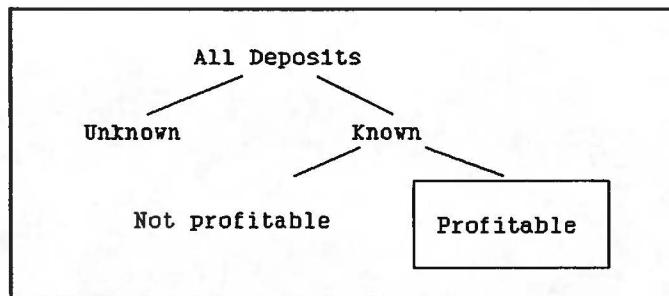


FIGURE 9. - Deposits included in estimates.

#### Regional Economic Benefits Estimated

Regional economic benefits associated with development and production at deposits in the EMNSA were estimated. Because the study reported here is limited to the EMNSA, the regional economic analysis is limited to the county which encompasses the EMNSA. This is San Bernardino County. The types of benefits estimated were value of output, personal earnings (i.e., wages and supplemental benefits), jobs, and taxes paid by mining companies.

Mining generates these benefits directly and indirectly. Direct benefits include production revenues and the personal earnings and employment of the labor forces for mine construction and production. "Revenues" of mines are the value of production, valued using breakeven prices (i.e., prices generating a 15 pct return). Taxes paid by mines are also a direct benefit. They include income, property, and sales taxes, plus permit fees.

Indirect regional benefits arise when other local industries spend what they receive from mines and mine employees. "Supporting local industry" refers to these industries. Only part of the total spending by mines and their employees goes to local suppliers. Data indicate that about 10 pct of mine spending is received locally, and lacking data on residency, it is assumed that half of the employees are county residents spending locally (even though data given in the following section suggest the fraction is larger). Figure 10 illustrates how mining generates regional benefits.

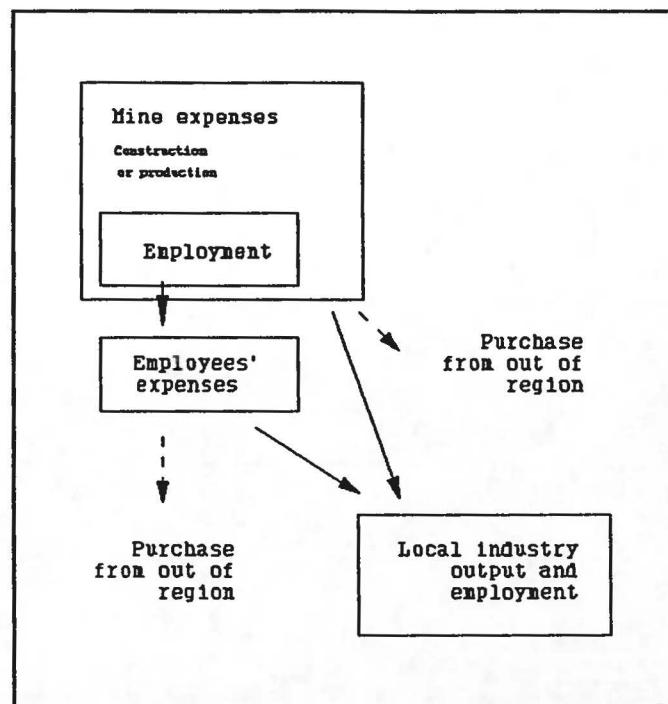


FIGURE 10. - Elements of regional impact analysis.

Impacts depend on timing as well as levels of mining activities. Undeveloped deposits included in the estimates can be developed on demand, but demand is not forecasted in this study. Nonetheless, in order to report aggregated results, simplifying assumptions about timing must be made. In the case of impacts reported in annual terms, the assumption is that all mines are operating at the same time; whereas, probably some mines will be operating and others not in any given year. In the case of cumulative impacts, a different simplification is needed. Cumulative totals cover all years of construction (if the deposit is presently undeveloped) or production over the deposit lifetime. A lifetime maximum of 20 yr is imposed on those deposits which have the potential to produce longer, and construction is assumed to take only 1 yr.

The remainder of this report focuses on the regional economic benefits from EMNSA mining. Regional impact analysis was done at the Bureau's Division of Policy Analysis (30).

#### SAN BERNARDINO COUNTY AND EMNSA MINERALS

##### Mining and the Regional Economy

At first glance, the share of mining in San Bernardino County employment, shown in table 5, seems small.

TABLE 5. - Employment in San Bernardino County

	<u>Jobs in 1987</u>
Agriculture.....	11,152
Mining.....	1,109
Construction.....	34,927
Manufacturing.....	49,099
Transport, utility.....	24,781
Trade, services.....	239,934
Government:	
Civilian.....	70,266
Military.....	<u>27,832</u>
 <u>Total.....</u>	 459,100

Source: Bureau of Economic Analysis,  
U.S. Dep. Commerce (April 1990). Includes  
proprietors as well as employees.

However, the San Bernardino economy is divided into urban and rural parts, and mining is an important employer in the rural part. This distinction is illustrated by figure 11, which shows that the County population is overwhelmingly in the western urban part. Employment in the Census tract containing the EMNSA is roughly estimated to be 2,000 to 3,000 persons (31); indeed, only about 500 persons reside in the EMNSA (32). Jobs and personal earnings in other sectors indirectly dependent on mining are an additional contribution, as are taxes paid by mines and supporting industries.

Tax revenues collected from mines were estimated in the present study, but the analysis stopped short of estimating government spending of the revenues. In fiscal year 1986-87, San Bernardino County collected from all industries and persons, \$114 million in property taxes and \$24 million in other taxes; \$257 million was granted by the State to the county, and \$150 million was granted by the Federal government (33). Taxes estimated for EMNSA mines are significant in this context; for example, annual property taxes under full access exceed \$3 million (table 11).

The full proposed withdrawals include more than the proposed Mojave Park, and their potential impacts would be felt in more counties. And, proposed withdrawals closer to the urban areas might constrain availability of construction materials.

Six mines were producing in the EMNSA at the time this study was done. These are:

Colosseum	gold
Morning Star	gold
Aiken	cinders
Rose	pyrophyllite
Hart	clay
Huntington	clay

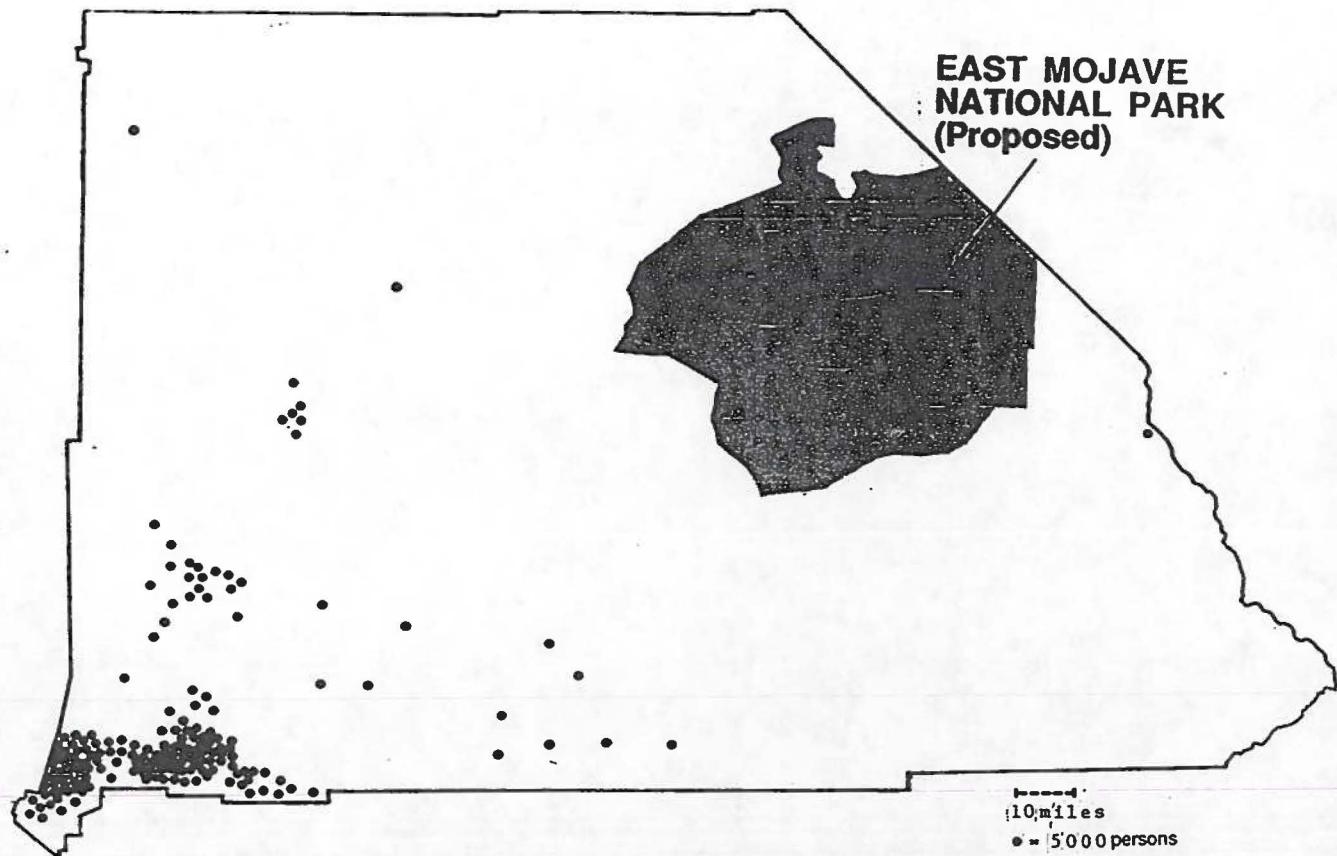


FIGURE 11. - San Bernardino County population distribution.  
Source: Data from Land Management Dep., San Bernardino County.

These mines are estimated to generate employment for San Bernardino County of 335 jobs. County personal earnings over the estimated remaining lifetimes of these mines (up to 20 yr) will accumulate to \$104 million.

#### ESTIMATES OF POTENTIAL ECONOMIC IMPACTS OF S 11/HR 780 and HR 3460

##### Summary of Impacts of Minerals Access Alternatives

Impacts of the two proposed withdrawals are presented here in contrast with a benchmark alternative, namely, full access to EMNSA minerals. None of the alternatives takes into account any regulatory and administrative restrictions to access in addition to legislative withdrawals. Types of impacts estimated and underlying assumptions are described under "Methodology" above, except that certain assumptions pertaining to individual tables are given below.

##### Full access to EMNSA minerals:

There are 24 known, apparently profitable mines or deposits within the boundaries of the EMNSA. The estimated production revenues of these minerals total \$3 billion.

Potential San Bernardino County personal earnings generated, directly and indirectly, by this mining accumulate to nearly \$1 billion over all years of construction and production (up to 20 yr). The average annual employment, summing over all mines and deposits, is about 2,400 jobs. An additional \$29 million in annual personal earnings and 840 jobs is generated by limestone product transport. Taxes estimated include over \$3 million annually in county property taxes and Federal and State income taxes accumulating to \$160 million.

##### HR 3460:

The wilderness areas proposed by HR 3460 that fall within the EMNSA boundary contain two undeveloped deposits. These deposits which would be made unavailable have estimated revenues of \$0.1 billion.

Cumulative county personal earnings generated by mining of the 22 deposits available under this alternative are about \$0.9 billion, and average annual employment, summing over all deposits, is 2,200 jobs. Estimated economic benefits from limestone product transport are the same as those for full access, and taxes paid are slightly less. The estimates given here omit the presently unprofitable or undiscovered deposits that would be unavailable in the wilderness areas.

S 11/HR 780:

The CDP Act would withdraw all undeveloped deposits in the EMNSA. For this study, the valid rights protection in S11/HR 780 is taken to mean that all existing mines and developed sites would be permitted to finish extracting their deposits. It is estimated that 15 presently undeveloped but known, profitable deposits would be unavailable. Although S 11/HR 780 would apparently allow extraction of \$1 billion (estimated revenues) at nine existing mines, \$2 billion at undeveloped sites would be unavailable.

Potential county personal earnings generated, directly and indirectly, by mining under this alternative accumulate to \$0.3 billion. The average annual employment, summing over all mines and deposits, is about 900 jobs. Taxes paid are roughly one-third those of full access. As all limestone deposits would be withdrawn, there are no estimated product transport benefits for the regional economy.

Other deposits are known which might become profitable in the future, and although not included in the estimates here, these would also be unavailable. Additionally, undiscovered deposits are omitted from the estimates, and many of these would be profitable when found; but they all would be unavailable under the CDP Act.

Potential impacts in terms of revenues are illustrated in figure 12 by commodity: (1) gold, (2) limestone and clinker, and (3) other commodities.

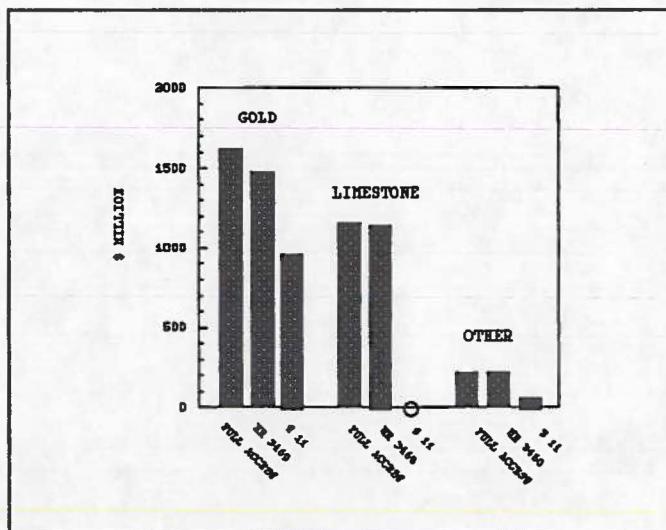


FIGURE 12. - Values of EMNSA minerals by commodity group (estimated production revenues).

### Tables of Estimated Impacts

Since some deposit data are proprietary, as explained in chapter 1, reported findings are aggregated into six groups:

Developed gold	- mining or developing as of 1990.
Developed clay	- operating as of 1990.
Other developed	- black sands, cinders, pyrophyllite operating or developed as of 1990.
Undeveloped limestone	- limestone and clinker.
Undeveloped gravel	- road aggregate and graded sand and gravel.
Undeveloped gold	

The S 11/HR 780 withdrawal would prevent mining at all undeveloped deposits (limestone, gravel, and gold). HR 3460 would withdraw a portion of the undeveloped gold deposits.

Table 6 shows potential impacts on the San Bernardino economy of construction of mines (including mills and roads). There are no construction expenses for mines already developed or operating but deposits under development at this time of this study can have such expenses. Under full access, construction at all deposits would cost \$342 million. County benefits are associated with the local share of this cost and they include (summing over all deposits) \$96 million in personal earnings and (assuming construction takes 1 yr) 3,035 jobs.

Table 7 shows economic benefits generated by mine production. Both revenues (calculated using break-even price as described earlier) and production cost are shown; under full access, annual revenues (for representative years) summed over all deposits amount to \$264 million. These revenues accumulate to \$3 billion over the lifetimes of the mines (up to 20 yr). Associated with the share of production cost that is spent locally are \$557 million in cumulative outputs of other supporting county industries. County personal earnings at mines and the supporting industries accumulate over the mine lifetimes to \$774 million, and these are earned at jobs averaging 1,964 annually (summing over all deposits).

Table 8 gives estimates of impacts from the part of the personal earnings of mine employees that is spent in San Bernardino County. Earnings from construction and production activities, shown separately, are both included. Under full access, outputs and employees' earnings at county businesses serving miners' households accumulate to \$244 million and \$72 million, respectively. Associated with these earnings are 312 annual jobs (summing over industries serving miners' households at all deposits).

TABLE 6. - Potential impacts of East Mojave National Scenic Area mine construction

	Annual mine expenditure, \$ M	Annual supporting local industry outputs, \$ M	Annual personal earnings at mine and supporting local industries, \$ M	Annual jobs at mine and supporting local industries \$ M
<b>Benefits under:</b>				
Full access.....	341.996	104.656	95.531	3,035
HR 3460.....	320.875	97.783	88.058	2,781
S 11/HR 780.....	83.965	23.599	20.768	639
<b>Breakdown of benefits by commodity, under full access:</b>				
Developed gold.....	78.707	21.989	19.130	589
Developed clays.....	0	0	0	0
Other developed.....	5.258	1.611	1.638	50
Undeveloped limestone....	138.530	42.585	38.016	1,161
Undeveloped gravel.....	15.910	6.000	2.826	110
Undeveloped gold.....	103.591	32.471	33.921	1,125
<b>Total.....</b>	<b>341.996</b>	<b>104.656</b>	<b>95.531</b>	<b>3,035</b>

NOTE.--See "Methodology" for definitions of terms used in table 6. It is assumed for this table that construction at every deposit takes 1 yr. Annual totals for expenditures, outputs, earnings, and jobs are the sum over all deposits. None of the alternatives takes into account any administrative restrictions on access additional to legislative withdrawals.

TABLE 7. - Potential impacts of East Mojave National Scenic Area mine production

	Annual revenues, \$ M	Annual production cost, \$ M	Cumulative mine revenues, \$ M	Benefits to San Bernardino County		
				Cumulative supporting local industries outputs, \$ M	Cumulative personal earnings at mines and supporting industries, \$ M	Annual jobs at mines and supporting local industries
<b>Benefits under:</b>						
Full access.....	264.333	203.562	3,001.26	557.534	773.669	1,964
HR 3460.....	246.363	186.890	2,857.50	539.830	728.541	1,799
S 11/HR 780.....	113.783	79.871	1,033.78	208.237	272.853	796
<b>Breakdown of benefits by commodity, under full access:</b>						
Developed gold.....	110.404	77.411	967.96	201.728	254.309	772
Developed clays.....	0.410	0.366	8.20	0.824	1.800	3
Other developed.....	2.969	2.094	57.62	5.685	16.744	20
Undeveloped limestone.	57.732	44.831	1,154.64	240.696	249.688	360
Undeveloped gravel....	9.903	6.828	149.52	15.649	48.400	78
Undeveloped gold.....	82.915	72.032	663.32	92.952	202.728	731
<b>Total.....</b>	<b>264.333</b>	<b>203.562</b>	<b>3,001.26</b>	<b>557.534</b>	<b>773.669</b>	<b>1,964</b>

NOTE.--See "Methodology" for definitions of terms used in table 7. Cumulative revenues are the sum over all deposits of production over the life of the mine (up to 20 yr), where production is valued by the price generating a 15 pct return. Annual revenues are the sum of revenues in representative years for all deposits. Cumulative personal earnings sum over all years of production (up to 20 yr) for all deposits. Annual jobs are the sum over all deposits of average annual employment in production. None of the alternatives takes into account any administrative restrictions on access additional to legislative withdrawals.

TABLE 8. - Potential impacts of East Mojave National Scenic Area mine employees' expenses

	Benefits to San Bernardino County of local spending of earnings				
Annual personal earnings during construction, \$ M	Annual personal earnings during production, \$ M	Cumulative supporting local industries output, \$ M	Cumulative personal earnings at supporting local industries, \$ M	Total annual jobs at supporting local industries	
<b>Benefits under:</b>					
Full access.....	61.191	57.834	243.835	71.964	312
HR 3460.....	55.645	52.640	227.010	67.000	284
S 11/HR 780.....	12.884	23.209	81.257	23.996	122
<b>Breakdown of benefits by commodity, under full access:</b>					
Developed gold.....	11.773	22.373	75.014	22.146	117
Developed clays.....	0	0.074	0.520	0.160	1
Other developed.....	1.111	0.762	5.724	1.689	4
Undeveloped limestone....	23.318	9.155	73.738	21.754	53
Undeveloped gravel.....	0.869	2.932	15.826	4.670	15
Undeveloped gold.....	24.120	22.538	73.013	21.545	122
<b>Total.....</b>	<b>61.191</b>	<b>57.834</b>	<b>243.835</b>	<b>71.964</b>	<b>312</b>

NOTE.--See "Methodology" for definitions of terms used in table 8. Cumulative outputs and personal earnings at county industries sum over all years of construction and production (up to 20 yr) for all deposits. Annual jobs are the sum over all supporting industries of annual employment, averaged over all years of mine construction and production. None of the alternatives takes into account any administrative restrictions on access additional to legislative withdrawals.

Grand totals of potential impacts from mining are given in table 9. All phases are included: construction, production, and employees' expenditure. For convenience, revenues are repeated from table 4. The potential regional significance of EMNSA mining is demonstrated here: output of all 24 deposits under full access accumulates to \$3 billion, and associated with this is \$906 million output in other, supporting county industries. Employment in this table is the weighted average of that in tables 3 and 4, plus that in table 5; the average annual employment generated by the 24 deposits and supporting industries is 2,379 jobs (summing over all deposits and industries).

Transportation and processing of minerals mined also generate considerable impacts. These are most important for limestone and clinker, which are high weight, locally-processed construction materials. Table 10 gives economic benefits estimated for transport of these products. Annual expense of \$40 million (summing over the three deposits concerned) generates 840 county jobs. Expenditures on transport by rail have been estimated using mine-mill models. It is assumed that railroad services are purchased entirely from San Bernardino County establishments, and employment and personal earnings generated by these railroads are estimated from the IMPLAN database (34).

Taxes that would be paid by mines in the study area are reported in table 11. These taxes have been estimated by Nicholas Wetzel at the Western Field Operations Center using mine models. Income and property taxes are calculated using mine production revenues based on prices generating a 15 pct return; if actual prices are higher than the break-even levels, taxes paid will be greater than the estimates given here. Under full access, income taxes for California State and for the U.S. accumulate (over the lifetimes of the mines) to \$34 million and \$126 million, respectively. County property taxes paid are shown as an annual average equal to \$3.6 million (summing over all deposits). The permit fees sum to \$23 million, and sales taxes paid by the mines account to \$15 million on purchases during construction and average \$4.6 million annually during production (summing over all deposits).

TABLE 9. - Total potential impacts of East Mojave National Scenic Area mine construction and production

	Cumulative mine revenues, \$ M	Cumulative sup- porting local industries' outputs, \$ M	Cumulative per- sonal earnings at mines and other supporting local industries, \$ M	Benefits to San Bernardino County Total annual jobs at mines and other sup- porting local industries
<b>Benefits under:</b>				
Full access.....	3,001.26	906.026	941.160	2,379
HR 3460.....	2,857.50	864.623	883.595	2,165
S 11/HR 780.....	1,033.78	313.095	317.614	936
<b>Breakdown of benefits by commodity, under full access:</b>				
Developed gold.....	967.96	298.731	295.585	907
Developed clays.....	8.20	1.344	1.960	4
Other developed.....	57.62	13.019	20.071	27
Undeveloped limestone....	1,154.64	357.008	309.458	452
Undeveloped gravel.....	149.52	37.476	55.895	94
Undeveloped gold.....	663.32	198.448	258.191	895
<b>Total.....</b>	<b>3,001.26</b>	<b>906.026</b>	<b>941.160</b>	<b>2,379</b>

NOTE.--Includes impacts of mine employees' expenses. See "Methodology" for definitions of terms used in table 9. Cumulative revenues are the sum over all deposits of production over the life of the mine (up to 20 yr), where production is valued by the price generating a 15 pct return. Cumulative outputs at supporting industries and personal earnings at mines and supporting industries sum over all years of construction and production (up to 20 yr) for all deposits. Annual jobs are the sum over all deposits of annual employment, averaged over all years of mine construction and production. None of the alternatives takes into account any administrative restrictions on access additional to legislative withdrawals.

TABLE 10. - Potential impacts of limestone product transport  
from East Mojave National Scenic Area

Annual rail transport expense, \$ M.....	39.955
Benefits to San Bernardino County:	
Cumulative railroads and supporting local industries' outputs, \$ M.	75.658
Cumulative personal earnings at railroads and supporting local industries, \$ M.	29.446
Annual jobs at railroads and supporting local industries.	840

NOTE.--These benefits are available under full  
access and HR 3460.

TABLE 11. - Taxes paid by mines, East Mojave National Scenic Area (\$ M)

	Cumulative State income	Cumulative Federal income	Annual San Bernardino property	Construction permit	Sales tax paid during construction	Annual sales tax during production
<b>Benefits under:</b>						
Full access.....	34.251	125.841	3.610	23.156	15.320	4.612
HR 3460.....	33.392	122.684	3.413	21.770	14.777	4.329
S 11/HR 780.....	9.681	35.581	1.349	5.244	2.223	2.634
<b>Breakdown of benefits by commodity, under full access:</b>						
Developed gold.....	8.638	31.734	1.313	4.816	2.093	2.609
Developed clays.....	0.050	0.188	0.004	0	0	0.002
Other developed.....	0.993	3.659	0.032	0.428	0.130	0.023
Undeveloped limestone.	18.007	66.144	1.268	10.098	9.577	0.374
Undeveloped gravel....	1.985	7.291	0.084	0.140	0.651	0.148
Undeveloped gold.....	4.578	16.825	0.909	7.674	2.869	1.456
<b>Total.....</b>	<b>34.251</b>	<b>125.841</b>	<b>3.610</b>	<b>23.156</b>	<b>15.320</b>	<b>4.612</b>

NOTE.--Cumulative San Bernardino property taxes amount to \$46 million under full access. See "Methodology" for definitions for definitions of terms used in table 11. Cumulative taxes are the sum over all deposits of production over the life of the mine (up to 20 yr), where production is valued by the price generating a 15 pct return. Annual taxes are the sum over all deposits of average annual taxes. None of the alternatives takes into account any administrative restrictions on access additional to legislative withdrawals.

## REFERENCES

24. Under a multiyear program, Inventory of Land Use Restraints, reports on various restraints affecting mining in known deposit areas have been published for most western States. For example, see Availability of Land for Mineral Exploration and Development in Arizona, 1986, Bureau of Mines, USDI (Washington, DC, 1986). A report in this program is being prepared presently covering the CDCA. Information of a different type is provided by the potential supply program, namely, estimates of the supply of minerals, known and presently undiscovered, in specific areas. See Potential Supply of Minerals from the White Mountains National Recreation Area and the Steese National Conservation Area in Alaska, Bureau of Mines, USDI, OFR 12-89 (Washington, DC, Apr. 1989); contains citations to previous work.

25. See General Accounting Office, "California Desert: Planned Wildlife Protection and Enhancement Objectives Not Achieved." GAO/RCED-89-171 (Washington, DC, July 1989).

26. Testimony before House Interior Committee, Parks and Lands Subcommittee, by W. T. Goerold, July 27, 1989; published by Wilderness Society (Washington, DC).

27. BLM has published minerals information building on its California Desert Conservation Area Final Environmental Impact Statement and Plan, Bureau of Land Management, USDI (Washington, DC and Sacramento, CA, Sept. 1980). See especially the main volume and also appendix XIV, Geology-Energy-Minerals. The Bureau of Mines has published information based on previous surveys of mining activity and potential: Mineral Summary: Background Data for the California Desert Protection Act of 1987, Western Field Operations Center of the Bureau of Mines, USDI (Spokane, WA) and U.S. Geological Survey, USDI (May 1988). The California Mining Association (through its Desert Conservation Institute) sponsored an economic study; however, it did not address the issue of the minerals values that would be withdrawn by S 11/HR 780, but instead, estimated the value of active mining in the total CDCA. See "Mineral Resources of the California Desert and Their Significance to California's Economy," Shirley Anderson, in California Desert Mineral Symposium: Compendium, California Office of Bureau of Land Management, USDI (Sacramento, CA, 1989).

28. Mines and deposits were identified and modeled by Nicholas Wetzel and Nicholas Zilka at the Bureau's Western Field Operations Center (WFOC), Spokane, WA. Previous work by WFOC using the methodology includes the Ft. Irwin Expansion: Environmental Impact Statement (Army Corps of Engineers, presently unpublished). Evidence employed in identifying undeveloped deposits in the EMNSA included: (1) active claims held by major mining companies which are evidence that deposits are being seriously considered for development, and (2) Bureau field work verifying existence and significance of deposits. Ore quantities and grades were estimated for identified deposits. Financial analysis verified profitability.

29. "Potential Supply," op. cit.

30. Regional impact estimates were made using a modified IMPLAN model. The IMPLAN system is maintained by the USFS (Fort Collins, CO); see Micro Implan, G Alward et al (Univ. of Minnesota, St. Paul, MN). Recent studies of regional economics include The Importance of Mining and Minerals Processing to Idaho, Bureau of Mines, USDI (Washington, DC, 1986) and contributions by the Bureau of Mines in 1988 to BLM Environmental Impact Statements for Birch Creek, for Minto Flats, and for Fourymile River, Alaska; as well as the Ft. Irwin EIS (op. cit.). See also, "IMPLAN Applications in Minerals Assessment for Land Management Planning," R. Schantz, Bureau of Mines, USDI (Washington, DC, 1990).

31. The estimate 2,000 to 3,000 is derived from the ratios of census tract 103 employment in 1980 of 1,199, 1980 population of 2,210, and 1985 population (Population-Housing Bulletin, Land Management Department, San Bernardino County). Similar methods can be used to estimate present day employment in neighboring areas, and the results are: total of rural tracts adjacent to tract 103--9,000 to 10,000 civilians employed; Needles area--3,000 to 4,000 civilians employed; and Barstow area--22,000 to 24,000.

32 . Permanent population of the East Mojave National Scenic Area, from East Mojave National Scenic Area Management Plan, Bureau of Land Management, USDI (Needles, CA, 1988).

33. California County Fact Book '88-'89, County Supervisors Association of California (Sacramento, CA).

34. See IMPLAN op cit. Adjustments were made to IMPLAN wage rates to reflect data in Statistical Abstract of the United States, 1989, U.S. Department of Commerce. Average hourly production wage in class I railroads was \$14.29, implying annual wages of roughly \$40,000. Average wage in supporting industries is assumed to be the California wide average, roughly \$23,000. Supplements to wages are assumed to average about 10 pct of wages.